L. Prabu* et al.
(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.2, February - March 2016, 2857 – 2863.

Experimental Investigation on Mechanical Properties of Hybrid and Rice Husk Fiber Reinforced Polyester Based Composite for Truck Body Application

L.PRABU
Department of Mechanical engineering
Sri Shanmugha College of Engineering and Technology
Salem, India

A.VINOTH
Department of Mechanical engineering
Sri Shanmugha College of Engineering and Technology
Salem, India

Dr.M.SENTHILKUMAR
Department of Mechanical engineering
Sri Shanmugha College of Engineering and Technology
Salem, India

Abstract— **World is as of now concentrating on alternate material sources that are environment agreeable and biodegradable in nature. Because of the expanding natural concerns, bio composite produced out of regular fiber and polyester resin, is one of the late advancements in the business and constitutes the present extent of experimental work. In this project our objective is to improve the mechanical properties of the polymer (polyester) by the reinforcement of rice husk& hybrid fiber of banana along with rice husk for truck body building application. The composite material, reinforced with hybrid fibers which include banana fiber, rice husk and rice husk separately in fiber form with the help of polyester resin was formed. Also Composite formed, was made into test specimens for experimentation. The strength of the formed composite materials was determined by conducting various tests such as tensile test, impact test for all the composites. The water absorption test was conducted for ensuring the ability of absorbing the water. Also the machining test, paint ability and assembly tests were performed for assessing the suitability for the truck body building and operating conditions. From the results it was observed that the hybrid fiber reinforced composite shows the better result in terms of strength, machinability, paint ability, water absorption level and assembly operations when compared to the other composite materials.**

Keywords- **Composite Materials; Truck Body Building; Rice Husk; Hybrid Materials; Manufacturing**

I. INTRODUCTION

The composite materials could be termed as those materials which are synthesized by two or more materials having diverse properties. By and large, composites materials have strong load carrying reinforcing material imbedded in weaker lattice materials. The primary constituent of composites have a nonstop stage which is the significant a piece of the composite is called matrix. Matrix are by and large more ductile and less hard and these are generally either inorganic or natural. Optional constituent of composites have ductile called reinforcement and they are implanted in the matrix. The constituents of composite materials have their property however when they are consolidated together, they give a blend of properties that a singular can't have the capacity to give. Generally, composite materials are arranged on the basis of matrix materials as:

- Ceramic Matrix Composites
- Polymer Matrix Composites
- Metal Matrix Composites

Ceramic matrix composite-The composite which is consisting of a ceramic combined with a ceramic dispersed phase. Because of availability of new technologies, the demand for high performance products and processing methods, have together improve the growth of advanced ceramic products, but brittleness of ceramics still retain a major disadvantage.

Polymer matrix composite-Polymer matrix composites are recognized to be a more conspicuous class of composites when contrasted with artistic or metal lattice composites once in business requisitions. It includes a matrix from thermoplastic (polystyrene, nylon) or thermosetting (epoxy, unsaturated polyester) or and inserted steel, glass carbon, or Kevlar strands.

Metal matrix composite- Composites consisting of metal matrix such as Mg, Al, Fe is called metal matrix composites. They are of exhibit good stiffness, light weight, and low specific weight as compared to other metal alloys and metals. Although it has many advantages, low cost remains a major point of interest for many applications.

Among these all types of composites, polymer matrix composite is most commonly used composites, because of its advantages such as high strength, low cost, simple manufacturing principle.

High tensile strength and high creep resistance at increases in temperatures.

Fiber: The attraction in utilizing natural fiber, for example, distinctive wood fiber and plant fiber as support in plastics has expanded drastically throughout last few years. Concerning the ecological viewpoints if natural fibers might be utilized rather than glass fibers as fortification in some structural provisions it might be extremely intriguing. Natural fibers have numerous points of interest contrasted with glass fiber, for instance they have low thickness, and they are biodegradable and recyclable. Also they are renewable crude materials and have generally great strength and stiffness.

Natural fibers are classified on the basis of the origin of source, in three types

- Plant Fibers
- Mineral Fibers
- Animal Fibers

Plant Fibers-Plant fibers are usually consists of cellulose: examples cotton, jute, bamboo, flax, ramie, hemp, coir and sisal. Cellulose fibers are used in various applications. The category of these fibers is as following Seed fibers are those which obtain from the seed e.g. Kapok and cotton. These fibers having superior tensile properties than the other fibers. Because of these reason these fibers are used in many applications such as packaging, paper and fabric. Fruit fibers are the fibers generally are obtain from the fruit of the plant, e.g. banana fiber and coconut fiber. Similarly, stalk fiber are the fibers which are obtain from the stalks (rice straws, bamboo, wheat and barley). Leaf fibers are the fibers those are obtain from the leaves (agave and sisal). Skin fibers are those fibers which are obtain from the bast or skin surrounding the stem of the plant.

Mineral Fibers- Mineral fibers are those which are get from minerals. These are naturally happening fiber or somewhat changed fiber. It has different classifications they are taking after: Asbestos is the main characteristically happening mineral fiber. The Variations in mineral fiber are the serpentine, amphiboles and anthophyllite. The Ceramic filaments are glass fiber, aluminum oxide and boron carbide. Metal filaments incorporate aluminums strands.

Animal Fibers- Animal fiber by and large comprises of proteins; cases, silk, alpaca, mohair, downy. Animal hair is the strands got from creatures e.g. Sheep's downy, goat hair, horse hair, alpaca hair, and so forth. Silk fiber is the filaments gathered from dry saliva of bugs or creepy crawlies throughout the time of planning of cocoons. Avian strands are the fiber from fowls [1]. Composites of natural fiber used for drives of structural, but typically with synthetic thermoset matrix which of course bound the environmental benefits. Now a day's natural fiber composites application are usually found in building and automotive industry and the place where dimensional constancy under moist and high thermal conditions and load bearing capacity are of importance [2,3]. Natural fibers like cotton, sisal, jute, abaca, pineapple and coir have already been studied like a reinforcement and filler in composites. Among various natural fibers, banana fiber is considered as a potential reinforced in polymer composites due to its many advantages such as easy availability, low cost, comparable strength properties etc. Generally, natural fibers are consists of cellulose, lignin, pectin etc.

II. TRUCK BODY BUILDING

The bodywork conveys the essential identity and aesthetic appeal of the Vehicle the drab functionality of utility vehicles, the actual material from which it is fabricated has until recently attracted relatively little interest. However, of all the components comprising the overall vehicle, the skin and underlying structural framework provide some of the most interesting advances in materials and associated process technology. This is reflected in the many changes which have taken place in the body materials used for the automotive body structures over 100 years of production, commencing with the replacement of the largely handcrafted bodies constructed from sheet metal, fabric and timber superseded during the 1920s, by sheet steel. Environmental issues and the increasing effects these may have influence on materials selection. Profit generation is obviously the lifeblood of the industry and the effects of globalization and economies of scale on design and the consequent ability to absorb change quickly are next considered.

Figure 1.Truck body building process

III. METHODOLOGY

The proposed research work comprises of following stages which was explained below in detail

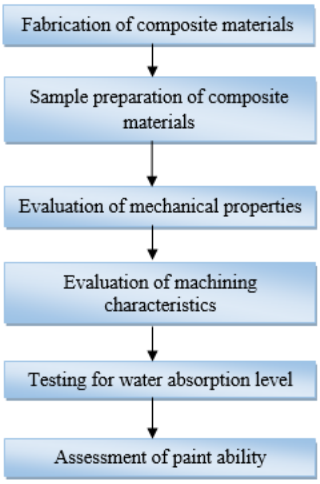

Figure 2.Flowchart of research work

IV. SYNTHESIS OF COMPOSITE MATERIALS

A. Preparation of Banana fiber composite

The banana fiber is obtained from banana plant, which has been collected from local sources. The extracted banana fiber were subsequently sun dried for eight hours then dried in oven for 24 hours at 105° C to remove free water present in the fiber. The dried fibers were subsequently cut into lengths of 1, 2mm. The polyester resins and hardener are procured from reputed brands. The banana fiber based polyester composite is fabricated using hand lay-up process.

Figure 3.Banana fiber

B. Preparation of rice husk composite

The preparation of rice husk is also called paddy waste collect from the agriculture the cultivation of rice husk having attractive in terms of energy. Although the technology for rice husk utilization is well-proven in industrialized countries of Europe and North America, such technologies are yet to be introduced in the developing world on commercial scale.

Figure 4.Rice husk

Table.1 Composite material description

Category	Composite Description
Hybrid	Fiber length (1 mm) (40%) + polyester (60%)
Rice husk	Fiber length (1 mm) (40 %) + polyester (60 %)

Materials used for composite material preparation

- Banana fiber
- Rice husk
- Polyester
- Hardener
- Accelerator

Materials used for composite material preparation

- Banana fiber
- Rice husk
- Polyester
- Hardener
- Accelerator
- Acetone

A. Sample preparation of composite materials

The mould has been prepared with dimensions of 20×20×3 cm3. The banana and raise husk fiber of different length has been mixed with matrix mixture with their respective values by simple mechanical stirring and mixture is slowly poured in different mould, keeping the characterization standards and view on testing condition. The releasing agent has been use on mould sheet which give easy to composites removal from the mould after curing the composites. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 30° C duration 24 hour the constant load of 50 kg is applied on the job. The mould in which the mixture of the banana and rice husk, polyester resin and hardener has been poured. After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards.

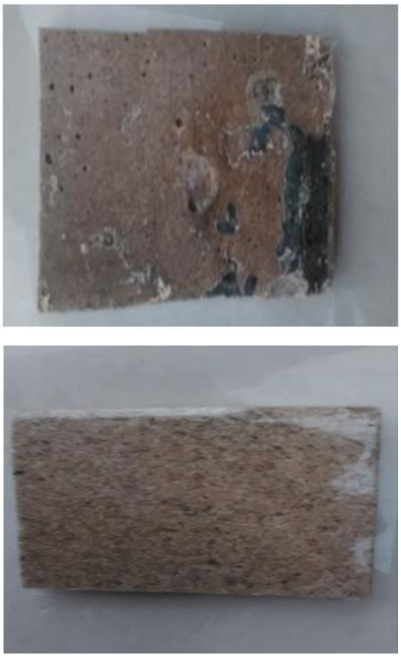

Figure 5.Prepared specimens

V. EXPERIMENTATION PROCEDURE

A. Tensile Strength Test

Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. For the tensile test, the specimen size was 150 × 15 mm2 and gauge length was 70 mm. Tensile strength was tested in Universal Testing machine. The specimen with desired dimension was fixed in the grips of the machine with 7 mm gauge length.

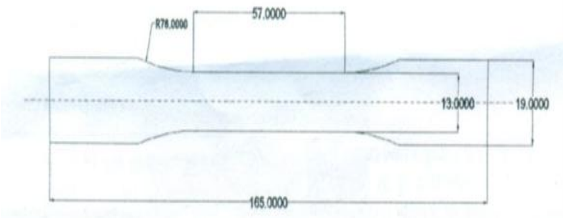

Figure 6. ASTM dimensions for Tensile test

B. Impact Strength Test

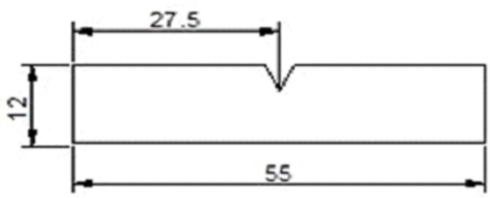

Figure 7.ASTM dimensions for Impact test

Izod impact testing is a method of determining the impact resistance of composites. In impact test, an arm held at a specific height is released during the testing. The arm impacted on the sample and breaks the sample. Its impact energy is obtained from the energy absorbed by the composite or sample. The prepared composite material was made as Specimen having dimension 60 mm × 15 mm was tested in impact testing machine for identifying impact load carrying capacity.

C. Evaluation of machining properties

For machining operation, the composite specimens were cut in a shape of rectangular. The size of the specimen is 40×40×10 mm and fitted into tool dynamometer hub. The machining properties of prepared composites were studied by drilling dynamometer analysis. In this proposed work, the drill hole made by composite material by using 4mm, 6mm and 8mm HSS drill bit at 500 rpm and the thrust force was measured.

D. Water Absorption test

Moisture absorption studies were performed according to ASTM D 570-98 standard test method for moisture absorption of plastics. The weights of the samples were taken and then dipped them to normal water. After 24 h, the samples were taken out from the moist environment and all surface moisture was removed with the help of a clean dry cloth or tissue paper. Then the samples were reweighed to the nearest 0.001 mg within 1 min of removing them from the environment chamber. The samples were regularly weighed at 24, 48, 72, 96,120, 144, 168, 192 hrs respectively. The moisture absorption was calculated by the weight difference. The weight gain in percentage of the samples was measured at regular time intervals of time by using the following equation:

$$\%w = (wt - w_o)/w_o \times 100$$

Where

Wt - The weight of specimen at a given immersion time

Wo - The dried weight of specimen

E. Painting test

The prepared composite material was painted with the commercial paints for assessing the level of paint adhesiveness with the composite.

VI. RESULTS & DISCUSSIONS

A. Influence of Fiber Parameters on Tensile strength

The mechanical behavior of the banana and raise husk fiber based polyester composites depends on fiber parameters. The influence of fiber length and loading on tensile properties of composites is shown in table.3. It has been observed that the tensile strength of composites increases with increase in fiber length and loading. From the results it was observed that the composite having both banana fiber and rice husk gives a better properties equivalent to the conventional wood in terms of breaking load and tensile strength, when compared to rice husk composite.

Figure 6.Specimen for tensile test as per ASTM standard

Table.2 Mechanical properties of composite material

Category	Breaking Load (kN)	Maximum Displacemen (mm)	Tensile Strength MPa
Hybrid	7.0	4.3	26.1
Raise husk	6.5	3	23.94
wood	7.1	5.5	26.15

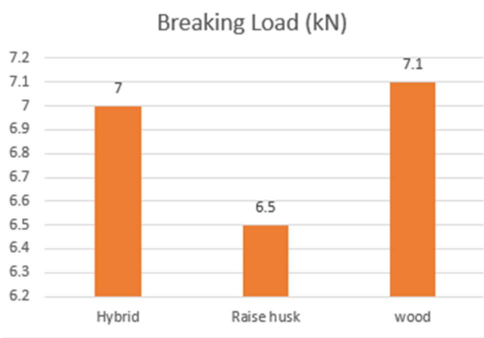

Figure 7. Breaking Load (kN)

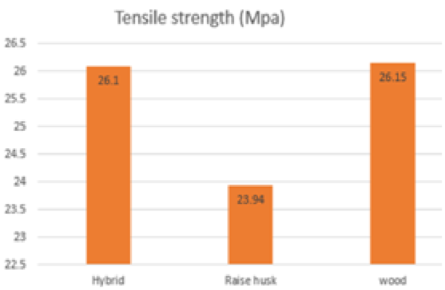

Figure 8. Tensile Strength (MPa)

B. Influence of Fiber Parameter on Impact Strength

The test results for impact energy are shown in Table 4. From the result it is observed that the impact energy is increases with increase in fiber length. It also show that the impact energy increases with increases in fiber loading. The maximum impact energy absorbed by the material 15 mm length of fiber and 20% fiber content. Hybrid composite having banana fiber and rice husk exhibits a better result in absorbing impact energy when compared to other composite.

Figure 9. Specimen for Impact test as per standard

Table.3 Impact test of composite material

Category	Energy absorbed (J/mm^2)	
	Izod Test	Charpy Test
Hybrid	6	8
Rice husk	6	7
Wood	7	8

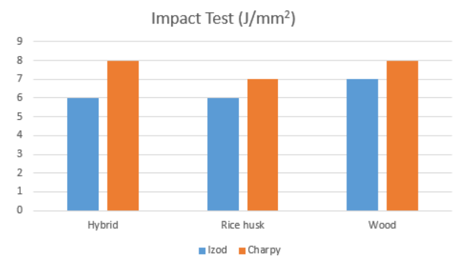

Figure 10. Impact test of composite material

C. Influence of Fiber Parameter on machining operation

The fabricated composite and wood was drilled with the aid of drilling machine for assessing the machining characteristics. Three holes of diameter 4mm, 6mm and 8mm was done on the 4 mm thickness of formed composite materials. During the drilling operation the drilling force was acquired through drilling tool dynamometer. The drilling tool force was shown in figure.14 & figure.15 From the results the dimensional accuracy was observed for hybrid fiber composite and also the force required for drill the same was less when compared to the other rice husk composite and wood.

Figure 11. Drilled specimens

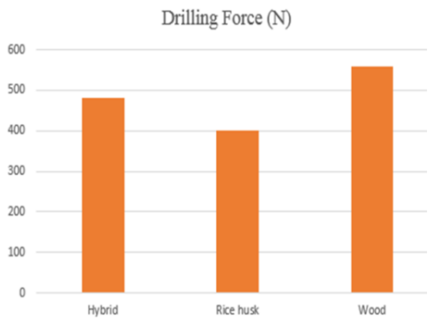

Figure 12. Drilled Force (N)

D. Water absorption behavior of composites

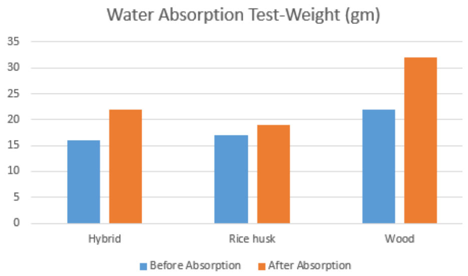

Figure 13. Specimen weight before and after water absorption test

Water absorption test is very important to determine the water absorption ability of the material. The percentage of weight gain in various composites with time duration is shown in Figure. It is observed from the Figure1 that with increase in fiber loading the water absorption gradually increases irrespective of fiber orientation. There are three main reasons in the composite because of which water can reside in composite. Those are the lumen, the cell wall and the gaps between fiber and resin in the case of weak interface adhesion is found. The maximum water absorption obtains at 50% fiber loading irrespective of fiber orientation. As far as effect of fiber orientation on the water absorption of composites is concerned there is not much influence is observed.

E. Material Cost and weight analysis

Table.4 Cost and weight analysis of composite material

Composites	**Weight (gm)**	**1 Square feet (Rs)**	**Composites**
Hybrid	310	17	Hybrid
Rice husk	280	15	Rice husk
Wood	350	20	Wood

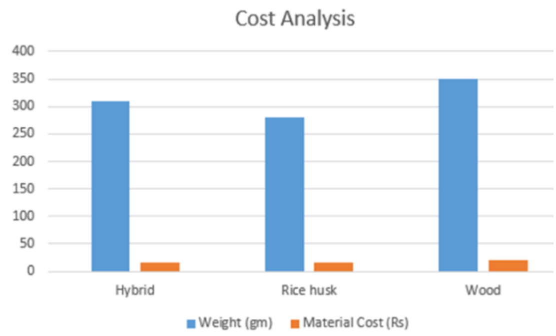

Figure 14. Cost and weight analysis of composite material

VII. CONCLUSIONS

The composite material, reinforced with hybrid fibers which include banana fiber, rice husk and rice husk separately in fiber form with the help of polyester resin was formed. Various tests were conducted such as tensile test, impact test, water absorption test, machining test to determine the strength and suitability for the truck body application. From the experimental results the following conclusions were arrived. The tensile strength was observed to the 5.37% increased for hybrid composite when compared to other. For hybrid composite the impact strength was observed to be 10% higher than the other. From the water absorption rice husk composites shows low absorption water level when compared to hybrid composite. For machining operation the thrust force was reduced by 42% while drilling hybrid composite than other composite.

VIII. REFERENCES

[1]. Bledzki AK, Gassan J. Composites reinforced with cellulose based fibers. Prog Polym Sci 1999;24:221–74.

[2]. Mwaikambo LY, Ansell MP. Chemical modification of hemp, sisal, jute, and kapok fibers by alkalization. J Appl Polym Sci 2002;84(12):2222–34.

[3]. Jochen Gassan. A study of fiber and interface parameters affecting the fatigue behavior of natural fiber composites. Composites Part A: 2002;33(3):369–74.

[4]. Ruys D, Crosky A, Evans WJ. Natural based fiber structure. Int J Mater Product Technol 2002;17(1–2):2–10.

[5]. Mishra S, Tripathy SS, Misra M, Mohanty AK, Nayak SK. Novel ecofriendly bio composites: bio fiber reinforced biodegradable polyester amide composites – fabrication and properties evaluation. J Reinf Plast Comp 2002;21(1):55–70.

[6]. Kandachar P, Brouwer R. Applications of bio-composites in industrial products. Mater Res Soc Symp Proc 2002;702:101–12.

[7]. Anon. The competitiveness of natural fibers based composites in the automotive sector the Sisal Agribusiness in Brazil.Mater Res Soc Symp Proc 2002;702:113–39.

[8]. Santulli C. Post-impact damage characterization on natural fiber reinforced composites using acoustic emission. NDT&E International 2001;34(8):531–6.

[9]. Van de Velde K, Kiekens P. Thermoplastic pultrusion of natural fiber reinforced composites. Comp Struct 2001;54(2–3):355–60.

[10]. Gassan J, Chate A, Bledzki AK. Calculation of elastic properties of natural fibers. J Mater Sci 2001;36(15):3715–20.

